

Preliminary Survey of the Occurrence of Entomopathogenic Nematodes and Fungi in the Forest Soils of Algeria

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Abstract. The natural distribution and diversity of entomopathogenic nematodes (EPN) and fungi (EPF) in various biotopes in Algeria was studied, particularly in forests and plantations of cedar, oak, pine, eucalyptus and palm. The objective of this study was to identify EPN and/or EPF species which could be used to control forest insect pests. Soil sampling was carried out at 223 sites from April 2007 to March 2008. To trap EPN's juvenile larvae of Steinernematidae and Heterorhabditidae and EPF, the method of "insect-trap" was used in the laboratory. Caterpillars of *Galleria mellonella* (Lep., Pyralidae) and the forest insects *Thaumetopoea pityocampa* (Lep., Thaumetopoeidae) and *Lymantria dispar* (Lep. Lymantriidae) were used. The presence of EPN was noted in 8.1% of the sampled sites and EPF in 9.9%. The presence of the EPN in the oasis biotope may result from particular microclimate conditions (of temperature and humidity). Nematodes belonging to the Steinernematidae family and *Steinernema* genus were identified. In addition, 10 fungal species were isolated, namely: *Beauveria bassiana*, *Fusarium* sp., *Alternaria* sp., *Penicillium* sp., *Trichoderma* sp., *Sordaria* sp., *Mucor* sp., *Chaetomium globosum*, *Aspergillus nigriscans* and *Rhizopus nigriscans*. The majority of the fungi were isolated in the conidial form, except for *Chaetomium globosum* which had its perfect form with perithecia. The presence of EPN and EPF seems to depend on the dominant species of forest trees, either cork oak (35%), cedar (12.5%), pine (12.5%), palm (10%) or eucalyptus (7.5%).

Key words: Entomopathogenic; nematodes; fungi; forest insect pests; biological control; Algeria

Prospecção Preliminar de Nemátodos e Fungos Entomopatogénicos em Solos Florestais da Argélia

Sumário. A distribuição natural e a diversidade de nemátodos e fungos entomopatogénicos em vários biótipos da Argélia foram estudadas, incidindo particularmente em florestas de cedro, carvalho, pinheiro, eucalipto e palmeiras. O objetivo do estudo foi identificar nemátodos e/ou fungos que possam vir a ser utilizados em futuros programas de controlo biológico de pragas florestais. Amostragens de solo foram efetuadas em 223 locais da Argélia, entre Abril de 2007 e Março de 2008. Para capturar os nemátodos e fungos foi utilizado o método do "inseto-armadilha", usando-se como isca lagartas de *Galleria mellonella* (Lep., Pyralidae), *Thaumetopoea pityocampa* (Lep., Thaumetopoeidae) e *Lymantria dispar* (Lep. Lymantriidae). Detetou-se a presença de nemátodos entomopatogénicos em 8,1% dos locais amostrados e de fungos em 9,9%. A presença destes organismos em oásis pode derivar de características micro-climáticas particulares, nomeadamente

de temperatura e humidade. Foram identificados nemátodos pertencentes à família Steinernematidae e ao género *Steinernema*, e cerca de 10 espécies de fungos, nomeadamente: *Beauveria bassiana*, *Fusarium* sp., *Alternaria* sp., *Penicillium* sp., *Trichoderma* sp., *Sordaria* sp., *Mucor* sp., *Chaetomium globosum*, *Aspergillus nigriscans* e *Rhizopus nigriscans*. A maioria dos fungos foi isolada como conídios, excepto *Chaetomium globosum* que apresentou a forma perfeita com peritecas. A presença dos nemátodos e fungos parece estar dependente do coberto florestal dominante, seja ele sobreiro (35%), cedro (12,5%), pinheiro (12,5%), palmeira (10%) ou eucalipto (7,5%).

Palavras-chave: Entomopatogénico; nemátodos; fungo; pragas florestais; controlo biológico; Argélia

Introduction

During the last ten years, great efforts toward the increase and protection of forest trees in nurseries and agro-forestry plantations have been made in Algeria. To support these efforts, phytophagous insect pests must be controlled in young reforestation and also in nurseries. More than 100 000 hectares of reforestation and natural forests have been treated yearly against the principal defoliating forest insect pests, such as *Thaumetopoea pityocampa* (Lep. Thaumetopoeidae), *Lymantria dispar* (Lep. Lymantriidae), *Ephesia nymphaea* and *E. nymphagoga* (Lep. Noctuidae). However, these treatments may involve risks of polluting the environment, so it is essential to have alternative options to classic chemical insecticide treatments (ZAMOUM, 2002).

Entomopathogenic nematodes (EPN) from the Steinernematidae and Heterorhabditidae families and entomopathogenic fungi (EPF) have been used in various ecological conditions and have already demonstrated their potential for insect control (TARASCO and TRIGGIANI, 1997 and 2002; MARANNINO *et al.*, 2003). Indeed, the use of EPN and EPF is recommended in Algeria because of the vulnerability of the environment and the risks arising from the effects of pesticides on humans, animals, water and soil.

The main objectives of this study were (1) to assess the natural biodiversity and frequency of EPN and EPF in the soil from different forest habitats and (2) to select the species of EPN and/or EPF most suitable as biological control agents in reforestation and forests, in order to provide forest services with a technical application of EPN and EPF. This application can be used alone or combined with other biological control agents, particularly in more vulnerable habitats such as national parks, protected areas, infested areas and marginal forests.

Material and methods

Biotopes studied

Sampling was carried out in forests representing different ecological conditions in Algeria: coniferous forests (27%) (*Cedrus atlantica*, *Pinus halepensis*, *Pinus pinaster* and *Pinus nigra*), oak forest (35%) (*Quercus suber*, *Quercus ilex*, *Quercus faginea*), *Eucalyptus camaldulensis* and *E. gomphocephala* forests (2%), salt biotopes (13%), agro-forestry ecosystems (9%) and desert oasis (14%). With these diverse habitats we aimed at collecting EPN and EPF representative of and adapted to diverse bioclimatic and ecological contexts.

Soil sampling and EPN/EPF collection

Each of the 223 samples analysed consisted of about 2kg of soil, composed of 3-4 sub samples collected at depths between 10-20cm and over an area of approximately 20-50m² in each location. For each sample the nearest town, locality, texture of the soil, pH, organic matter and organic carbon, elevation and vegetation cover was recorded.

The soil was transported to the laboratory in sterile plastic bags. The "insect-trap" method was used to attract nematodes and/or fungi: in each soil sample 3 or 4 Lepidoptera larvae (L3 or L4 development stage) of *Galleria mellonella*, *Lymantria dispar*, *Catocala* sp. and *Thaumetopoea pityocampa* were placed in a long-handled tea infuser as bait insects (Figure 1). Samples were stored in an air-conditioned room at 25°C for a period of 7 to 10 days. Infected

caterpillars were kept in a room at about 23°C to isolate entomopathogenic microorganisms.

Results and discussion

Entomopathogenic nematodes were detected in 8.1% of the sampled locations, being more common in the forest environments (which were the most common locations, at 65%) and also in wetland, sub-humid locations and cedar plantations in altitude, although they were also recovered from the desert oasis.

The EPF were observed in 9.9% of the sites, being more frequent in the wetland and desert locations (Figure 2). The presence of both nematodes and fungi in the desert oasis may result from particular microclimate conditions of temperature and humidity within that specific biotype.



Figure 1 - Long-handled tea infuser with handle used for the insect baiting technique (Photo: E. Tarasco)

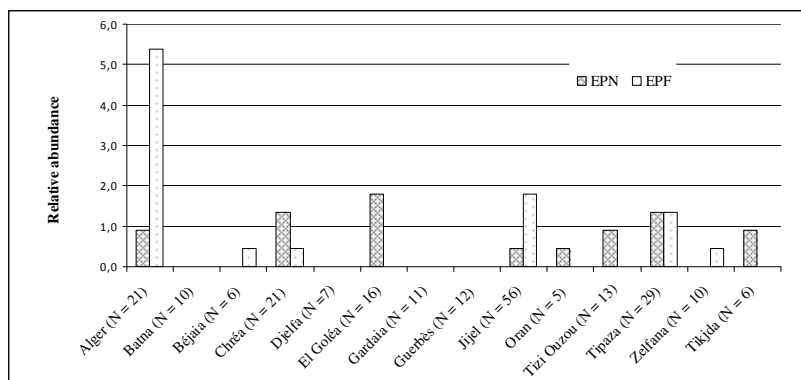


Figure 2 - Relative abundance of EPN and EPF according to the Algerian localities

All the nematodes isolated from the 223 soil samples belonged to a single genus, *Steinernema*. Previous surveys conducted in southern Italy found a higher diversity than in Algeria (TARASCO and TRIGGIANI, 1997; TARASCO *et al.*, 1997).

The species *Steinernema feltiae* was identified from soil samples nearby Algiers (Baïnem forest), on *E. camaldulensis* (36°47'945" N and 002°57'203" E, 163m) and *Q. suber* (36°47'877"N 002°57'235" E, 183m) stands. The following parameters were recorded for each site: pH 7.8 and 7.9, organic carbon 1.28 and 0.08, organic matter 2.21 and 0.13.

Steinernema feltiae is known for its high ecological polyvalence and has been used with success to control caterpillars of *Thaumetopoea pityocampa* (Lep., Thaumetopoeidae) in young *P. halepensis* reforestation in Southern Italy (TARASCO and TRIGGIANI, 2002). These results offer promising perspectives of using this species to control insect forest pests such as *T. pityocampa*, *Thaumetopoea bonjeani*, *Lymantria dispar* or *Catocala* sp. in Algeria.

Among the EPF detected in northern

and southern Algeria, *Beauveria bassiana* was the most frequently encountered fungus in the various ecological conditions. This species is known for its impact on the regulation of insect pest populations. The other four species of fungi found were detected in humid stations and forests located at high altitude, although *Fusarium* sp. was observed widespread in various other stations (Figure 3).

Conclusion

These preliminary results have contributed to the knowledge of the biodiversity complex of EPN and EPF in different geographic and climatological regions characteristic of Algeria. The identification and potential use of EPN and EPF as bio-control agents against insect forest pests remain an objective of much interest. Indeed, the production of EPF/EPN virulent species or strains to be employed against insect pests would be an innovation in the biological control techniques in Algeria which would reduce the risks of pollution and toxicity in the environment caused by classic insecticide control techniques.

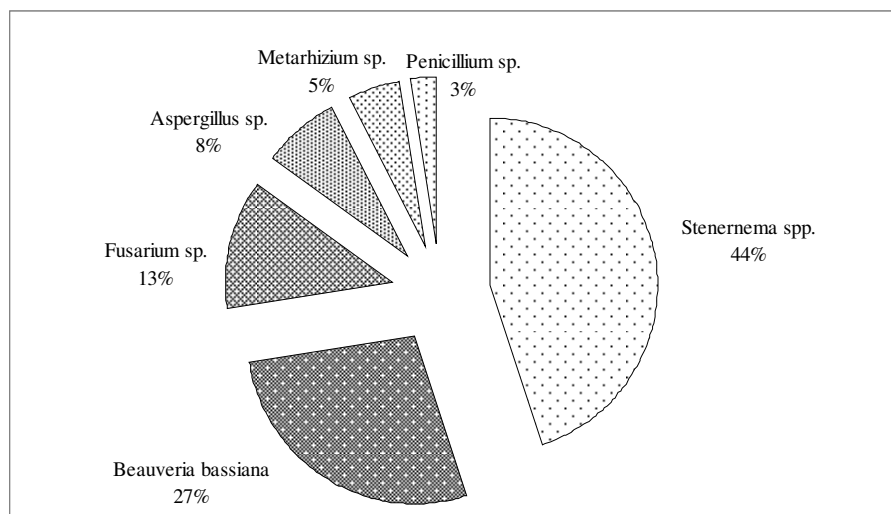


Figure 3 - Frequency of EPN and EPF species recorded in Algeria

Acknowledgements

Thanks to the Algerian and Italian authorities who financed this scientific research under the scientific collaboration project between the National Institute of Forestry Research (INRF) and the University of Bari (Italy).

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